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Yosui

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(54) **FLEXIBLE BOARD AND ELECTRONIC DEVICE**

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(51) **Int. Cl.**

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H05K 1/02	(2006.01)
H04M 1/02	(2006.01)
H05K 1/11	(2006.01)
H05K 5/00	(2006.01)

(52) **U.S. Cl.**

CPC ***H05K 1/0237*** (2013.01); ***H04M 1/0202*** (2013.01); ***H05K 1/02*** (2013.01); ***H05K 1/115*** (2013.01); ***H05K 5/0026*** (2013.01); *H05K 2201/055* (2013.01); *H05K 2201/10189* (2013.01)

(58) **Field of Classification Search**

CPC H05K 1/02; H05K 1/028; H05K 1/147; H05K 1/118; H04M 1/0202

USPC 455/575.1, 550.1; 361/749, 751; 174/254, 255

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2007/0089900	A1 *	4/2007	Mitamura et al.	174/254
2009/0002829	A1 *	1/2009	Shinohara	359/565
2010/0197368	A1 *	8/2010	Kawate et al.	455/575.1
2012/0274423	A1	11/2012	Kato	

FOREIGN PATENT DOCUMENTS

JP	2008-235593	A	10/2008
JP	2009-176901	A	8/2009
WO	2012/073591	A1	6/2012

OTHER PUBLICATIONS

Official Communication issued in International Patent Application No. PCT/JP2013/083329, mailed on Mar. 11, 2014.

* cited by examiner

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(57) **ABSTRACT**

A flexible board includes a flexible body and a linear conductor. The flexible body includes a first main surface and a second main surface. The linear conductor is provided at the flexible body so as to be located closer to the first main surface than to the second main surface. The flexible body is valley-folded along a line crossing the linear conductor such that the first main surface is located inside of the fold, and is mountain-folded along a line crossing the linear conductor such that the first main surface is outside of the fold. An average radius of curvature in an area where the flexible body is mountain-folded is greater than an average radius of curvature in an area where the flexible body is valley-folded.

20 Claims, 6 Drawing Sheets

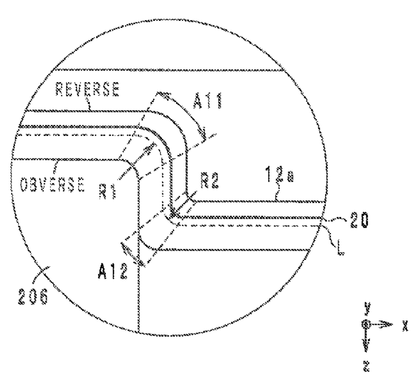


FIG. 1

10

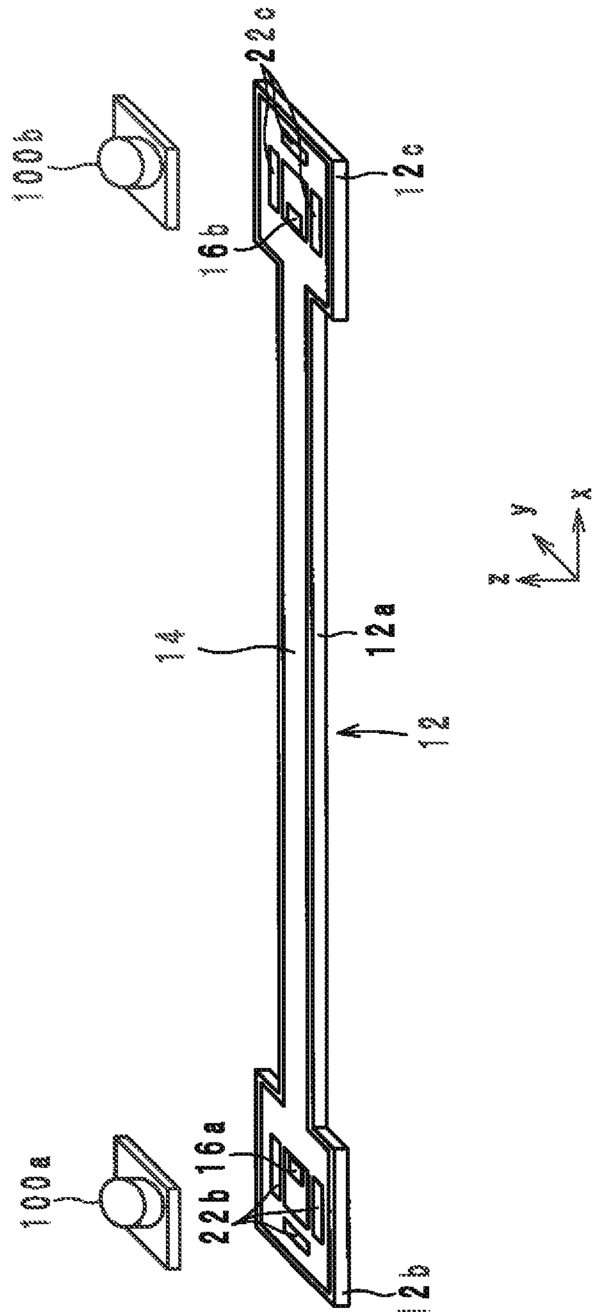
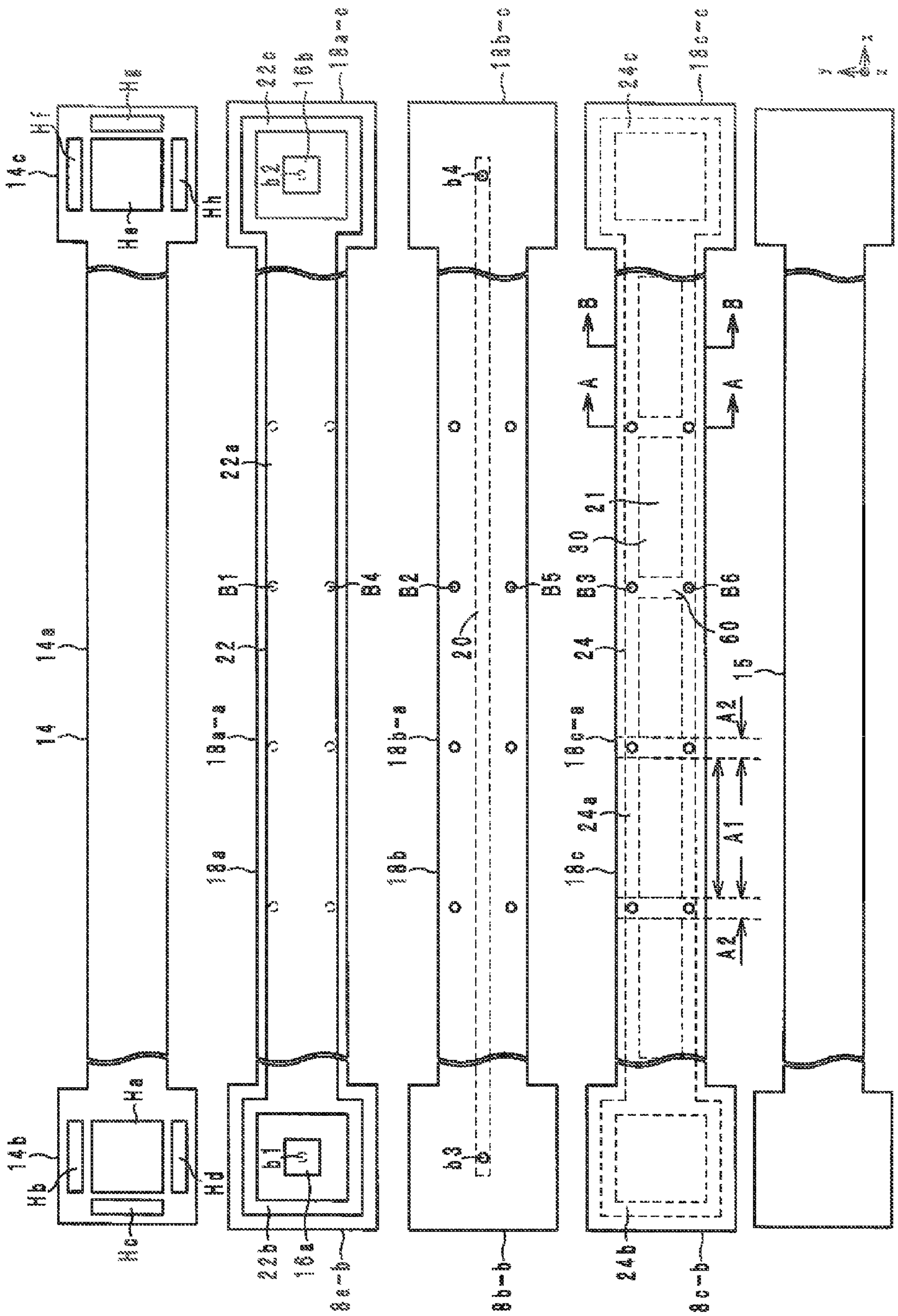
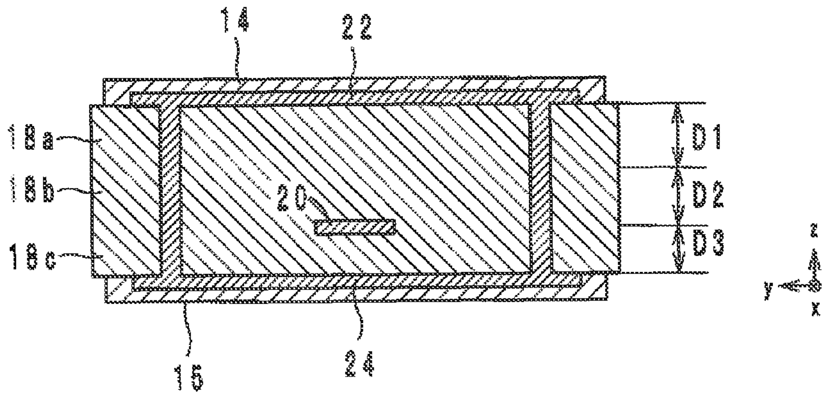


FIG. 2



12
14
14a
14b
14c
Ha
Hb
Hc
Hd
He
Hf
Hg
Hh
18a
18a-a
18a-b
18a-c
22
22a
22b
22c
16a
16b
b1
b2
B1
B4
18b
18b-a
18b-b
18b-c
20
b3
b4
B2
B5
18c
18c-a
18c-b
18c-c
24
24a
24b
24c
21
30
60
B3
B6
A
B
A1
A2
15

FIG. 3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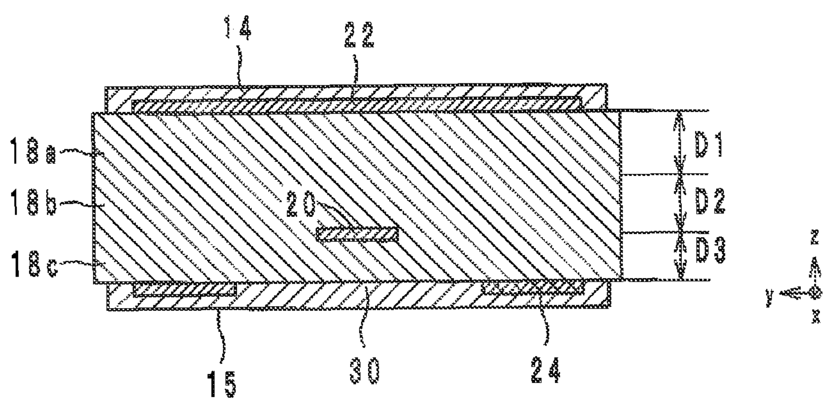
22
18a
18b
18c
20
D1
D2
D3
z
y
x
15
24

FIG. 4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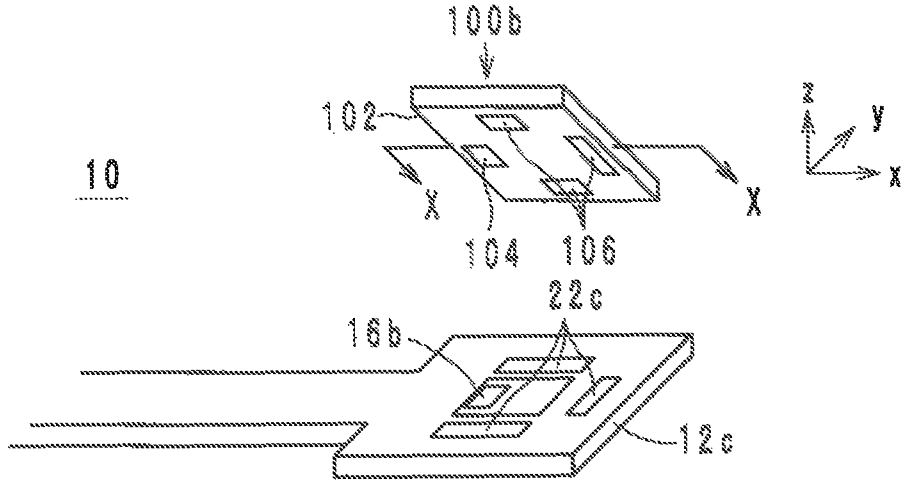
22
18a
18b
18c
20
D1
D2
D3
z
y
x
15
30
24

F I G . 5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102
X
X
z
y
x
10
104
106
22c
16b
12c

F I G . 6

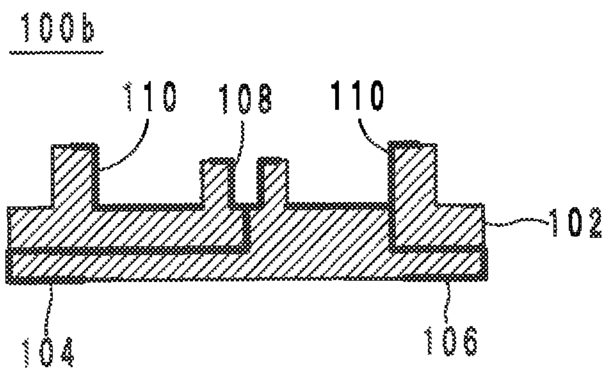

100b
110
108
110
102
104
106

FIG. 7

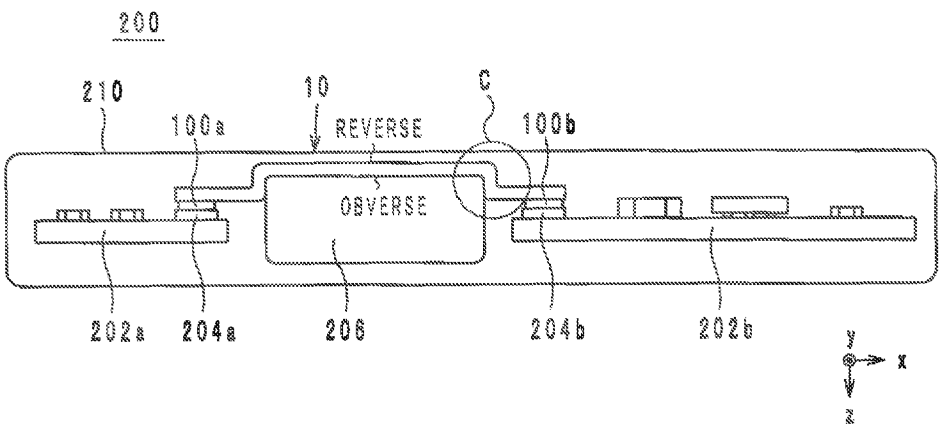

200
210
10
C
100a
REVERSE
100b
OBVERSE
202a
204a
206
204b
202b
y
x
z

FIG. 8

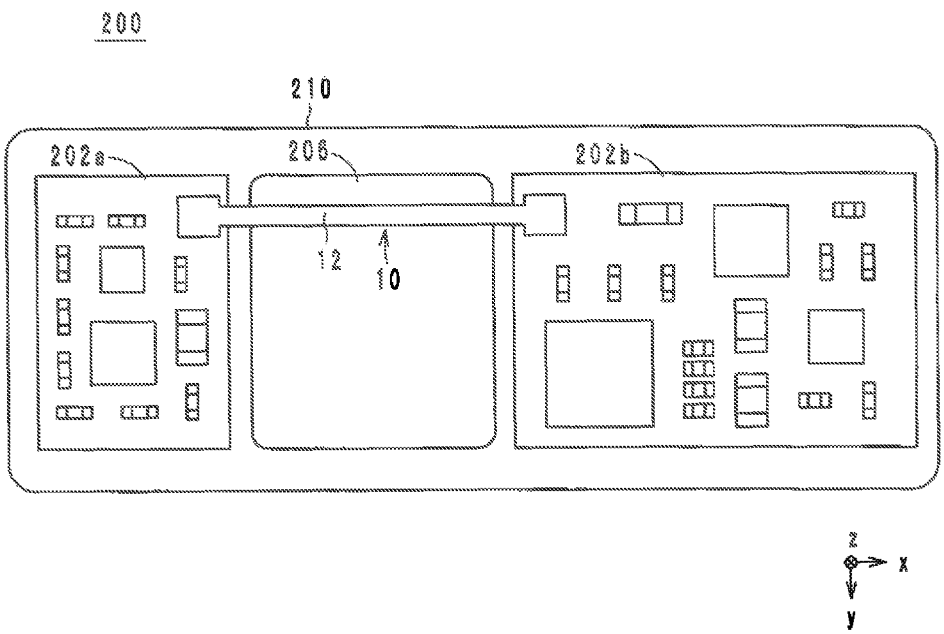

200
210
202a
206
202b
12
10
z
x
y

FIG. 9

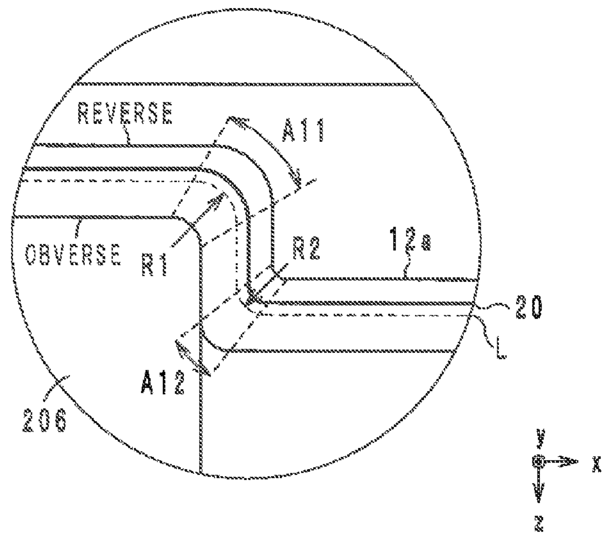
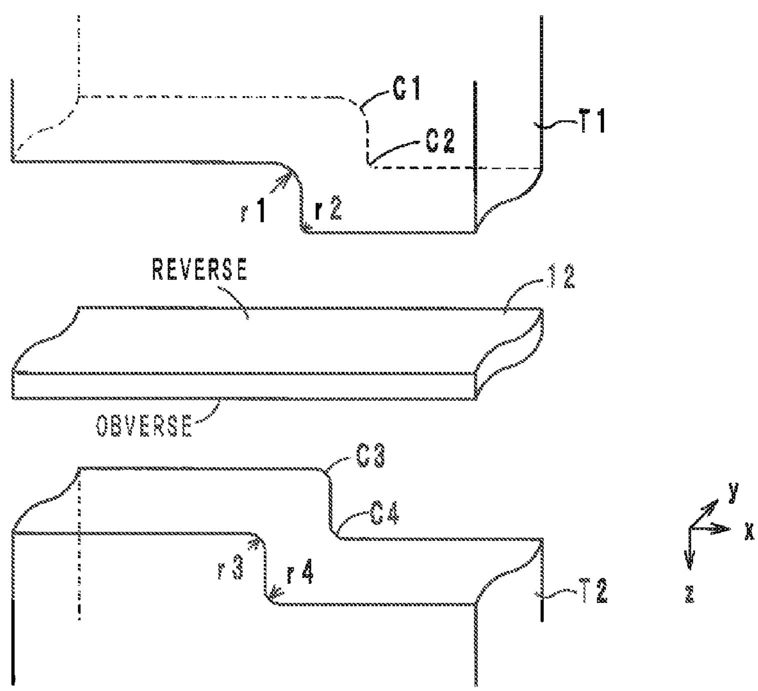

REVERSE
A11
OBVERSE
R1
R2
12a
20
L
A12
206
y
x
z

FIG. 10


C1
C2
T1
r1
r2
REVERSE
12
OBVERSE
C3
C4
r3
r4
T2
y
x
z

FLEXIBLE BOARD AND ELECTRONIC DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a flexible board and an electronic device, and more particularly to a flexible board including a linear conductor in a flexible body, and an electronic device.

2. Description of the Related Art

As a conventional flexible board, for example, a high-frequency signal line disclosed by WO 2012/073591 is known. The high-frequency signal line includes a dielectric body, a signal line and two ground conductors. The dielectric body is a laminate of dielectric sheets. The signal line is located in the dielectric body. The two ground conductors are located in the dielectric body so as to sandwich the signal line in the direction of lamination. Accordingly, the signal line and the two ground conductors form a stripline structure.

One of the ground conductors has a plurality of openings at positions over the signal line when viewed from the direction of lamination. Thereby, little capacitance is created between the signal line and the ground conductor. Therefore, it is possible to reduce the distance in the direction of lamination between the signal line and the ground conductor having the openings, and it is possible to make the high-frequency signal line thinner. This high-frequency signal line is used, for example, to connect two circuit boards.

The dielectric body of the high-frequency signal line disclosed by WO 2012/073591 is flexible, and the high-frequency signal line is bent when used. When the high-frequency signal line is bent, the signal line located in the dielectric body is stretched and/or compressed, and the signal line may be broken.

SUMMARY OF THE INVENTION

Preferred embodiments of the present invention provide a flexible board and an electronic device capable of diminishing the risk of breakage of a signal line.

A flexible board according to a preferred embodiment of the present invention includes a flexible body including a first main surface and a second main surface, and a linear conductor provided at the flexible body so as to be located closer to the first main surface than to the second main surface. The flexible body is valley-folded along a line crossing the linear conductor such that the first main surface is located inside of the fold, and is mountain-folded along a line crossing the linear conductor such that the first main surface is located outside of the fold, and an average radius of curvature in an area where the flexible body is mountain-folded is greater than an average radius of curvature in an area where the flexible body is valley-folded.

An electronic device according to a preferred embodiment of the present invention includes a case, and a flexible board housed in the case. The flexible board includes a flexible body including a first main surface and a second main surface, and a linear conductor provided at the flexible body so as to be located closer to the first main surface than to the second main surface. The flexible body is valley-folded along a line crossing the linear conductor such that the first main surface is located inside of the fold, and is mountain-folded along a line crossing the linear conductor such that the first main surface is located outside of the fold, and an average radius of curvature in an area where the flexible body is mountain-folded is greater than an average radius of curvature in an area where the flexible body is valley-folded.

Various preferred embodiments of the present invention prevent breakage of a signal line.

The above and other elements, features, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a high-frequency signal line according to a preferred embodiment of the present invention.

FIG. **2** is an exploded view of a dielectric body of the high-frequency signal line illustrated in FIG. **1**.

FIG. **3** is a sectional view cut along the line A-A indicated in FIG. **2**.

FIG. **4** is a sectional view cut along the line B-B indicated in FIG. **2**.

FIG. **5** is a perspective view of a connector of the high-frequency signal line.

FIG. **6** is a sectional view of the connector of the high-frequency signal line.

FIG. **7** is a plan view from a y-direction of an electronic device including the high-frequency signal line.

FIG. **8** is a plan view from a z-direction of the electronic device including the high-frequency signal line.

FIG. **9** is an enlarged view of the portion C indicated in FIG. **7**.

FIG. **10** illustrates a process of bending the high-frequency signal line.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A high-frequency signal line and an electronic device according to preferred embodiments of the present invention are hereinafter described with reference to the drawings.

The structure of a high-frequency signal line **10** according to a preferred embodiment of the present invention is described with reference to the drawings. FIG. **1** is a perspective view of the high-frequency signal line **10** according to the present preferred embodiment. FIG. **2** is an exploded view of a dielectric body **12** of the high-frequency signal line **10**. FIG. **3** is a sectional view cut along the line A-A indicated in FIG. **2**. FIG. **4** is a sectional view cut along the line B-B indicated in FIG. **2**. In the following, the direction of lamination of the high-frequency signal line **10** is defined as a z-direction. The lengthwise direction of the high-frequency signal line **10** is defined as an x-direction, and the direction perpendicular to the x-direction and the z-direction is defined as a y-direction.

The high-frequency signal line **10** is a flexible board that is used, for example, to connect two high-frequency circuits in an electronic device such as a cell phone. As illustrated in FIGS. **1** through **3**, the high-frequency signal line **10** includes a dielectric body **12**, external terminals **16***a* and **16***b*, a signal line **20**, a main ground conductor **22**, an auxiliary ground conductor **24**, via-hole conductors b**1** through b**4** and B**1** through B**6**, and connectors **100***a* and **100***b*.

The dielectric body **12** is, as illustrated in FIG. **1**, a flexible plate-shaped member extending in the x-direction when viewed from the z-direction. The dielectric body **12** includes a line portion **12***a*, and connecting portions **12***b* and **12***c*. As illustrated in FIG. **2**, the dielectric body **12** is a laminate including a protective layer **14**, dielectric sheets **18***a* through **18***c*, and a protective layer **15** laminated in this order from a positive side to a negative side in the z-direction. A main surface of the dielectric body **12** on the positive side in the z-direction is hereinafter referred to as an obverse surface (second main surface), and a main surface of the dielectric body **12** on the negative side in the z-direction is hereinafter referred to as a reverse surface (first main surface).

The line portion **12***a*, as seen in FIG. **1**, extends in the x-direction. The connecting portions **12***b* and **12***c* preferably are rectangular or substantially rectangular portions connected to a negative end and a positive end in the x-direction of the line portion **12***a*, respectively. The widths (sizes in the y-direction) of the connecting portions **12***b* and **12***c* are greater than the width (sizes in the y-direction) of the line portion **12***a*.

As illustrated in FIG. **2**, the dielectric sheets **18***a* through **18***c* have the same shape as the dielectric body **12** when viewed from the z-direction. The dielectric sheets **18***a* through **18***c* are preferably made of flexible thermoplastic resin, such as polyimide, liquid polymer or the like. In the following, a main surface of each of the dielectric sheets **18***a* through **18***c* on the positive side in the z-direction is referred to as an upper surface, and a main surface of each of the dielectric sheets **18***a* through **18***c* on the negative side in the z-direction is referred to as a lower surface.

As indicated in FIGS. **3** and **4**, the total of the thickness D1 of the dielectric sheet **18***a* and the thickness D2 of the dielectric sheet **18***b* is greater than the thickness D3 of the dielectric sheet **18***c*. After a laminating process of the dielectric sheets **18***a* through **18***c*, the total of the thickness D1 and the thickness D2 preferably is, for example, within a range from about 50 μm to about 300 μm. In this preferred embodiment, the total of the thickness D1 and the thickness D2 preferably is about 150 μm, for example. The thickness D1 preferably is about 75 μm, and the thickness D2 preferably is about 75 μm, for example. The thickness D3 preferably is, for example, within a range from about 10 μm to about 100 μm, for example. In this preferred embodiment, the thickness D2 preferably is about 50 μm, for example.

As illustrated in FIG. **2**, the dielectric sheet **18***a* includes a line portion **18***a-a*, and connecting portions **18***a-b* and **18***a-c*. The dielectric sheet **18***b* includes a line portion **18***b-a*, and connecting portions **18***b-b* and **18***b-c*. The dielectric sheet **18***c* includes a line portion **18***c-a*, and connecting portions **18***c-b* and **18***c-c*. The line portions **18***a-a*, **18***b-a* and **18***c-a* constitute the line portion **12***a*. The line portions **18***a-b*, **18***b-b* and **18***c-b* constitute the connecting portion **12***b*. The line portions **18***a-c*, **18***b-c* and **18***c-c* constitute the connecting portion **12***c*.

The signal line **20** is, as illustrated in FIGS. **2** through **4**, a linear conductor located in the dielectric body **12**, and the signal line **20** is to transmit a high-frequency signal. In this preferred embodiment, the signal line **20** is a linear conductor provided on the lower surface of the dielectric sheet **18***b* to extend in the x-direction. Accordingly, the signal line **20** is, as seen in FIGS. **3** and **4**, located closer to the reverse surface of the dielectric body **12** than to the obverse surface of the dielectric body **12**.

The negative end in the x-direction of the signal line **20** is, as seen in FIG. **2**, in the center of the connecting portion **18***b-b*. The positive end in the x-direction of the signal line **20** is, as seen in FIG. **2**, in the center of the connecting portion **18***b-c*. The signal line **20** is preferably made of a metal material with a low specific resistance including mainly silver or copper. The statement that the signal line **20** is provided on the lower surface of the dielectric sheet **18***b* means that the signal line **20** is preferably formed by plating the lower surface of the dielectric sheet **18***b* with a metal foil and by patterning the metal foil or that the signal line **20** is preferably formed by applying a metal foil on the lower surface of the dielectric sheet **18***b* and by patterning the metal foil. The surface of the signal line **20** is smoothened, and therefore, the surface of the signal line **20** in contact with the dielectric sheet **18***b* has a greater surface roughness than the surface of the signal line **20** out of contact with the dielectric sheet **18***b*.

As illustrated in FIGS. **2** through **4**, the main ground conductor (second ground conductor) **22** is a continuous conductor layer located between the signal line **20** and the obverse surface of the dielectric body **12**. More specifically, the main ground conductor **22** is provided on the upper surface of the dielectric sheet **18***a* to face the signal line **20** via the dielectric sheets **18***a* and **18***b*. The main ground conductor **22** has no openings at positions over the signal line **20**. The main conductor **22** is preferably made of a metal material with a low specific resistance containing mainly of silver or copper.

The statement that the main ground conductor **22** is provided on the upper surface of the dielectric sheet **18***a* means that the main ground conductor **22** is preferably formed by plating the upper surface of the dielectric sheet **18***a* with a metal foil and preferably by patterning the metal foil or that the main ground conductor **22** is formed preferably by applying a metal foil on the upper surface of the dielectric sheet **18***a* and by patterning the metal foil. The surface of the main ground conductor **22** is smoothened, and therefore, the surface of the main ground conductor **22** in contact with the dielectric sheet **18***a* has a greater surface roughness than the surface of the main ground conductor **22** out of contact with the dielectric sheet **18***a*.

As illustrated in FIG. **2**, the main ground conductor **22** includes a main conductor **22***a*, and terminal conductors **22***b* and **22***c*. The main conductor **22***a* is provided on the upper surface of the line portion **18***a-a* to extend in the x-direction. The terminal conductor **22***b* is provided on the upper surface of the connecting portion **18***a-b* and preferably is rectangular or substantially rectangular ring-shaped. The terminal conductor **22***b* is connected to the negative end in the x-direction of the main conductor **22***a*. The terminal conductor **22***c* is provided on the upper surface of the connecting portion **18***a-c* and preferably is rectangular or substantially rectangular ring-shaped. The terminal conductor **22***c* is connected to the positive end in the x-direction of the main conductor **22***a*.

The characteristic impedance of the high-frequency signal line **10** is determined mainly depending on the area where the signal line **20** and the main ground conductor **22** face each other, the distance between the signal line **20** and the main ground conductor **22** and the relative permittivity of the dielectric sheets **18***a* through **18***c*. Therefore, in a case where the high-frequency signal line **10** is intended to have characteristic impedance of about 50Ω, for example, the characteristic impedance of the high-frequency signal line **10** determined from the signal line **20** and the main ground conductor **22** is set, for example, to about 55Ω that is a little higher than about 50Ω, for example. Then, the configuration (sizes and shapes of openings **30**) of the auxiliary ground conductor **24** is adjusted such that the characteristic impedance of the high-frequency signal line **10** determined from the signal line **20**, the main ground conductor **22** and the auxiliary ground conductor **24** will be about 50Ω, for example. The configuration of the auxiliary ground conductor **24** will be described later. Thus, the continuous conductor layer **22** defines and functions as a main ground conductor.

As illustrated in FIG. **2**, the auxiliary ground conductor **24** is a conductor layer located between the signal line **20** and the reverse surface of the dielectric body **12**. More specifically, the auxiliary ground conductor **24** is provided on the lower surface of the dielectric sheet **18***c* to face the signal line **20** via the dielectric sheet **18***c*. The auxiliary ground conductor **24** is preferably made of a metal material with a low specific resistance containing mainly of silver or copper.

The statement that the auxiliary ground conductor **24** is provided on the lower surface of the dielectric sheet **18***c* means that the auxiliary ground conductor **24** is preferably formed by plating the lower surface of the dielectric sheet **18***c* with a metal foil and preferably by patterning the metal foil or that the auxiliary ground conductor **24** is formed preferably by applying a metal foil on the lower surface of the dielectric sheet **18***c* and by patterning the metal foil. The surface of the auxiliary ground conductor **24** is smoothened, and therefore, the surface of the auxiliary ground conductor **24** in contact with the dielectric sheet **18***c* has a greater surface roughness than the surface of the auxiliary ground conductor **24** out of contact with the dielectric sheet **18***c*.

As illustrated in FIG. **2**, the auxiliary ground conductor **24** includes a main conductor **24***a*, and terminal conductors **24***b* and **24***c*. The main conductor **24***a* is provided on the lower surface of the line portion **18***c-a* to extend in the x-direction. The terminal conductor **24***b* is provided on the lower surface of the connecting portion **18***c-b* and preferably is rectangular or substantially rectangular ring-shaped. The terminal conductor **24***b* is connected to the negative end in the x-direction of the main conductor **24***a*. The terminal conductor **24***c* is provided on the lower surface of the connecting portion **18***c-c* and is preferably is rectangular or substantially rectangular ring-shaped. The terminal conductor **24***c* is connected to the positive end in the x-direction of the main conductor **24***a*.

As illustrated in FIG. **2**, the main conductor **24***a* includes rectangular or substantially rectangular openings **30** aligned in the x-direction. Accordingly, the main conductor **24***a* is shaped like a ladder. In the main conductor **24***a*, the portions between the openings **30** are referred to as bridges **60**. Each of the bridges **60** extends in the y-direction. When viewed from the z-direction, the openings **30** and the bridges **60** are arranged alternately to be overlapped with the signal line **20**. In this preferred embodiment, the signal line **20** extends across the openings **30** and the bridges **60** in the center of the openings **30** and the bridges **60** with respect to the y-direction.

The auxiliary ground conductor **24** also functions as a shield. As mentioned above, the auxiliary ground conductor **24** is designed for final adjustment of the characteristic impedance of the high-frequency signal line **10** such that the characteristic impedance will be about 50Ω, for example.

As described above, the main ground conductor **22** does not have any openings, and the auxiliary ground conductor **24** includes the openings **30**. Therefore, the area where the auxiliary ground conductor **24** faces the signal line **20** is smaller than the area where the main ground conductor **22** faces the signal line **20**.

As seen in FIG. **2**, the external terminal **16***a* is a rectangular or substantially rectangular conductor provided in the center of the upper surface of the connecting portion **18***a-b* of the dielectric sheet **18***a*. When viewed from the z-direction, the external terminal **16***a* is located over the negative end in the x-direction of the signal line **20**. As seen in FIG. **2**, the external terminal **16***b* is a rectangular or substantially rectangular conductor provided in the center of the upper surface of the connecting portion **18***a-c* of the dielectric sheet **18***a*. When viewed from the z-direction, the external terminal **16***b* is located over the positive end in the x-direction of the signal line **20**. The external terminals **16***a* and **16***b* are preferably made of a metal material with a low specific resistance containing mainly of silver or copper. The surfaces of the external terminals **16***a* and **16***b* are plated with Ni/Au.

The statement that the external terminals **16***a* and **16***b* are provided on the upper surface of the dielectric sheet **18***a* means that the external terminals **16***a* and **16***b* are formed preferably by plating the upper surface of the dielectric sheet **18***a* with a metal foil and preferably by patterning the metal foil or that the external terminals **16***a* and **16***b* are formed preferably by applying a metal foil on the upper surface of the dielectric sheet **18***a* and by patterning the metal foil. The surfaces of the external terminals **16***a* and **16***b* are smoothened, and therefore, the respective surfaces of the external terminals **16***a* and **16***b* in contact with the dielectric sheet **18***a* have a greater surface roughness than the respective surfaces of the external terminals **16***a* and **16***b* out of contact with the dielectric sheet **18***a*.

The external terminals **16***a*, **16***b*, the signal line **20**, the main ground conductor **22** and the auxiliary ground conductor **24** have thicknesses equal or substantially equal to one another. The thicknesses of the external terminals **16***a*, **16***b*, the signal line **20**, the main ground conductor **22** and the auxiliary ground conductor **24** preferably are, for example, within a range from about 10 μm to about 20 μm.

As described above, the signal line **20** is sandwiched between the main ground conductor **22** and the auxiliary ground conductor **24** from the both sides in the z-direction. Thus, the signal line **20**, the main ground conductor **22** and the auxiliary ground conductor **24** define a triplate stripline structure. The interval (distance in the z-direction) between the signal line **20** and the main ground conductor **22** is, as illustrated in FIGS. **3** and **4**, equal or substantially equal to the total of the thickness D1 of the dielectric sheet **18***a* and the thickness D2 of the dielectric sheet **18***b*, and the interval preferably is, for example, within a range from about 50 μm to about 300 μm. In this preferred embodiment, the interval between the signal line **20** and the main ground conductor **22** preferably is about 150 μm, for example. The interval (distance in the z-direction) between the signal line **20** and the auxiliary ground conductor **24** is, as illustrated in FIGS. **3** and **4**, equal or substantially equal to the thickness D3 of the dielectric sheet **18***c*, and the interval preferably is, for example, within a range from about 10 μm to about 100 μm. In this preferred embodiment, the interval between the signal line **20** and the auxiliary ground conductor **24** preferably is about 50 μm. Thus, the distance in the z-direction between the auxiliary ground conductor **24** and the signal line **20** is smaller than the distance in the z-direction between the main ground conductor **22** and the signal line **20**.

The via-hole conductors B**1** are, as seen in FIG. **2**, pierced in the dielectric sheet **18***a* in the z-direction. The via-hole conductors B**1** are located farther in the positive y-direction than the signal line **20** and are aligned in the x-direction. As seen in FIG. **2**, the via-hole conductors B**2** are pierced in the dielectric sheet **18***b* in the z-direction. The via-hole conductors B**2** are located farther in the positive y-direction than the signal line **20** and are aligned in the x-direction. As seen in FIG. **2**, the via-hole conductors B**3** are pierced in the dielectric sheet **18***c* in the z-direction. The via-hole conductors B**3** are located farther in the positive y-direction than the signal line **20** and are aligned in the x-direction. The via-hole conductors B**1** are connected to the respectively adjacent via-hole conductors B**2**, and the via-hole conductors B**2** are connected to the respective adjacent via-hole conductors B**3**. Thus, each connected set of via-hole conductors B**1** through B**3** defines and serves as one via-hole conductor. The respective positive ends in the z-direction of the via-hole conductors B**1** are connected to the main ground conductor **22**. The respective negative ends in the z-direction of the via-hole conductors B**3** are connected to the auxiliary ground conductor **24**, and more specifically to the respective positive sides in the y-direction of the bridges **60**. The via-hole conductors B**1** through B**3** are formed preferably by filling via-holes made in the dielectric sheets **18***a* through **18***c* with conductive paste including silver, tin, copper or the like and by solidifying the conductive paste.

The via-hole conductors B**4** are, as seen in FIG. **2**, pierced in the dielectric sheet **18***a* in the z-direction. The via-hole conductors B**4** are located farther in the negative y-direction than the signal line **20** and are aligned in the x-direction. As seen in FIG. **2**, the via-hole conductors B**5** are pierced in the dielectric sheet **18***b* in the z-direction. The via-hole conductors B**5** are located farther in the negative y-direction than the signal line **20** and are aligned in the x-direction. As seen in FIG. **2**, the via-hole conductors B**6** are pierced in the dielectric sheet **18***c* in the z-direction. The via-hole conductors B**6** are located farther in the negative y-direction than the signal line **20** and are aligned in the x-direction. The via-hole conductors B**4** are connected to the respectively adjacent via-hole conductors B**5**, and the via-hole conductors B**5** are connected to the respective adjacent via-hole conductors B**6**. Thus, each connected set of via-hole conductors B**4** through B**6** defines and serves as one via-hole conductor. The respective positive ends in the z-direction of the via-hole conductors B**4** are connected to the main ground conductor **22**. The respective negative ends in the z-direction of the via-hole conductors B**3** are connected to the auxiliary ground conductor **24**, and more specifically to the respective negative sides in the y-direction of the bridges **60**. The via-hole conductors B**4** through B**6** are formed preferably by filling via-holes made in the dielectric sheets **18***a* through **18***c* with conductive paste including silver, tin, copper or the like and by solidifying the conductive paste.

The via-hole conductor b**1** is, as seen in FIG. **2**, pierced in the connecting portion **18***a-b* of the dielectric sheet **18***a* in the z-direction. The via-hole conductor b**3** is, as seen in FIG. **2**, pierced in the connecting portion **18***b-b* of the dielectric sheet **18***b* in the z-direction. The via-hole conductor b**1** and the via-hole conductor b**3** are connected to each other and serve as one via-hole conductor. The positive end in the z-direction of the via-hole conductor b**1** is connected to the external terminal **16***a*. The negative end in the z-direction of the via-hole conductor b**3** is connected to the negative end in the x-direction of the signal line **20**.

The via-hole conductor b**2** is, as seen in FIG. **2**, pierced in the connecting portion **18***a-c* of the dielectric sheet **18***a* in the z-direction. The via-hole conductor b**3** is, as seen in FIG. **2**, pierced in the connecting portion **18***b-c* of the dielectric sheet **18***b* in the z-direction. The via-hole conductor b**2** and the via-hole conductor b**4** are connected to each other and define and serve as one via-hole conductor. The positive end in the z-direction of the via-hole conductor b**2** is connected to the external terminal **16***b*. The negative end in the z-direction of the via-hole conductor b**4** is connected to the positive end in the x-direction of the signal line **20**. Thus, the signal line **20** is connected between the external terminals **16***a* and **16***b*. The via-hole conductors b**1** through b**4** are formed preferably by filling via-holes made in the dielectric sheets **18***a* and **18***b* with conductive paste including silver, tin, copper or the like and by solidifying the conductive paste.

The protective layer **14** is an insulating layer that covers the substantially entire upper surface of the dielectric sheet **18***a*. Accordingly, the protective layer **14** covers the main ground conductor **22**. The protective layer **14** is preferably made of, for example, flexible resin such as a resist material.

The protective layer **14**, as illustrated in FIG. **2**, includes a line portion **14***a*, and connecting portions **14***b* and **14***c*. The line portion **14***a* covers the substantially entire upper surface of the line portion **18***a-a* and accordingly covers the main conductor **22***a*.

The connecting portion **14***b* is connected to the negative end in the x-direction of the line portion **14***a* and covers the upper surface of the connecting portion **18***a-b*. However, the connecting portion **14***b* includes openings Ha through Hd. The opening Ha is a rectangular or substantially rectangular opening located in the center of the connecting portion **14***b*. The external terminal **16***a* is exposed to outside through the opening Ha. The opening Hb is a rectangular or substantially rectangular opening located farther in the positive y-direction than the opening Ha. The opening Hc is a rectangular or substantially rectangular opening located farther in the negative x-direction than the opening Ha. The opening Hd is a rectangular or substantially rectangular opening located farther in the negative y-direction than the opening Ha. The terminal conductor **22***b* is exposed to outside through the openings Hb through Hd and defines and functions as an external terminal.

The connecting portion **14***c* is connected to the positive end in the x-direction of the line portion **14***a* and covers the upper surface of the connecting portion **18***a-c*. However, the connecting portion **14***c* includes openings He through Hh. The opening He is a rectangular or substantially rectangular opening located in the center of the connecting portion **14***c*. The external terminal **16***b* is exposed to outside through the opening He. The opening Hf is a rectangular or substantially rectangular opening located farther in the positive y-direction than the opening He. The opening Hg is a rectangular or substantially rectangular opening located farther in the positive x-direction than the opening He. The opening Hh is a rectangular or substantially rectangular opening located farther in the negative y-direction than the opening He. The terminal conductor **22***c* is exposed to outside through the openings Hf through Hh and defines and functions as an external terminal.

The protective layer **15** is an insulating layer provided on the lower surface of the dielectric sheet **18***c* to cover the substantially entire lower surface of the dielectric sheet **18***c*. Accordingly, the protective layer **15** covers the auxiliary ground conductor **24**. The protective layer **15** is preferably made of, for example, flexible resin such as a resist material.

In the high-frequency signal line **10** having the structure above, the characteristic impedance of the signal line **20** changes cyclically between an impedance value Z1 and an impedance value Z2. More specifically, in areas A1 where the signal line **20** is over the openings **30**, relatively small capacitance is created between the signal line **20** and the auxiliary ground conductor **24**. Accordingly, the characteristic impedance of the signal line **20** in the areas A1 is a relatively high value Z1.

In areas A2 where the signal line **20** is located over the bridges **90**, on the other hand, relatively large capacitance is created between the signal line **20** and the auxiliary ground conductor **24**. Accordingly, the characteristic impedance of the signal line **20** in the areas A2 is a relatively low value Z2. In this regard, the areas A1 and the areas A2 are arranged alternately in the x-direction, and therefore, the characteristic impedance of the signal line **20** changes cyclically between the value Z1 and the value Z2. The impedance value Z1 is, for example, about 55Ω, and the impedance value Z2 is, for example, about 45Ω. The average characteristic impedance of the whole signal line **20** is, for example, about 50 Ω.

The connectors **100***a* and **100***b* are, as illustrated in FIG. **1**, mounted on the obverse surfaces of the connecting portions **12***b* and **12***c*, respectively. The connectors **100***a* and **100***b* have the same structure, and in the following, the structure of the connector **100***b* is described as an example. FIG. **5** is a perspective view of the connector **100***b* of the high-frequency signal line **10**. FIG. **6** is a sectional view of the connector **100***b* of the high-frequency signal line **10**.

The connector **100***b*, as illustrated in FIGS. **1**, **5** and **6**, includes a connector body **102**, external terminals **104** and **106**, a central conductor **108** and an external conductor **110**. The connector body **102** is in the shape of a rectangular or substantially rectangular plate with a cylinder connected thereon, and is preferably made of an insulating material such as resin.

The external terminal **104** is provided on the surface of the plate-shaped portion of the connector body **102** on the negative side in the z-direction so as to face the external terminal **16***b*. The external terminal **106** is provided on the surface of the plate-shaped portion of the connector body **102** on the negative side in the z-direction so as to face the terminal conductor **22***c* exposed through the openings Hf through Hh.

The central conductor **108** is located in the center of the cylindrical portion of the connector body **102** and is connected to the external terminal **104**. The central conductor **108** is a signal terminal at which a high-frequency signal is input or output. The external conductor **110** is provided on the inner surface of the cylindrical portion of the connector body **102** and is connected to the external terminal **106**. The external conductor **110** is aground terminal that is maintained at a ground potential.

The connector **100***b* having the structure above is, as illustrated in FIGS. **5** and **6**, mounted on the obverse surface of the connecting portion **12***c* such that the external terminal **104** is connected to the external terminal **16***b* and such that the external terminal **106** is connected to the terminal conductor **22***c*. As a result, the signal line **20** is electrically connected to the central conductor **108**, and the main ground conductor **22** and the auxiliary ground conductor **24** are electrically connected to the external conductor **110**.

The high-frequency signal line **10** is preferably used in the following way. FIG. **7** is a plan view from the y-direction of an electronic device **200** including the high-frequency signal line **10**. FIG. **8** is a plan view from the z-direction of the electronic device **200** including the high-frequency signal line **10**. FIG. **9** is an enlarged view of the portion C indicated in FIG. **7**.

The electronic device **200** includes the high-frequency signal line **10**, circuit boards **202***a* and **202***b*, receptacles **204***a* and **204***b*, a battery pack (metal object) **206**, and a case **210**.

As illustrated in FIGS. **7** and **8**, the case **210** houses the high-frequency signal line **10**, the circuit boards **202***a* and **202***b*, the receptacles **204***a* and **204***b*, and the battery pack **206**. In the circuit board **202***a*, for example, a transmitting circuit or a receiving circuit including an antenna is provided. In the circuit board **202***b*, for example, a feed circuit is provided. The battery pack **206** is, for example, a lithium-ion secondary battery, and the surface of the battery pack **206** is covered by a metal cover. The circuit board **202***a*, the battery pack **206** and the circuit board **202***b* are arranged in this order from the negative side to the positive side in the x-direction.

The receptacles **204***a* and **204***b* are provided on respective main surfaces of the circuit boards **202***a* and **202***b* on the negative side in the z-direction. The connectors **100***a* and **100***b* are connected to the receptacles **204***a* and **204***b* respectively. In this moment, the line portion **12***a* is bent as described below.

As seen in FIG. **7**, the dielectric body **12***a* is bent in a portion further in the positive x-direction than the center. In this portion, the line portion **12***a* is mountain-folded along a line crossing the signal line **20** such that the reverse surface of the dielectric body **12** is located outside of the fold. As a result, the dielectric body **12** is bent so as to extend on the surface of the battery pack **206** on the negative side in the z-direction and on the side surface of the battery pack **206** on the positive side in the x-direction. As indicated in FIG. **9**, the area where the dielectric body **12** is mountain-folded is hereinafter referred to as an area A11.

As seen FIG. **7**, the line portion **12***a* is also bent in a portion further in the positive x-direction than the area A11. In this portion, the line portion **12***a* is valley-folded along a line crossing the signal line **20** such that the reverse surface of the dielectric body **12** is inside of the fold. As a result, the dielectric body **12** is bent so as to further extend from the side surface of the battery pack **206** on the positive side in the x-direction to the main surface of the circuit board **202** on the positive side in the z-direction. As indicated in FIG. **9**, the area where the dielectric body **12** is valley-folded is hereinafter referred to as an area A12.

In this regard, the average radius of curvature R1 in the area A11 is greater than the average radius of curvature R2 in the area A12. In this preferred embodiment, the radius of curvature means the radius of curvature of an imaginary line L passing through the center of the dielectric body **12** with respect to the z-direction. With the structure of the high-frequency signal line **10**, breakage of the signal line **20** is reliably prevented as described below.

As in the portion of the dielectric body **12***a* farther in the positive x-direction than the center, the dielectric body **12***a* is also mountain-folded and valley-folded in a portion farther in the negative x-direction than the center. The folds of the dielectric body **12***a* in the portion farther in the negative x-direction than the center are similar to the folds of the dielectric body **12***a* in the portion farther in the positive x-direction than the center, and a description thereof is omitted.

When the connectors **100***a* and **100***b* are connected to the receptacles **204***a* and **204***b* respectively, a high-frequency signal with a frequency of, for example, 2 GHz transmitted between the circuit boards **202***a* and **202***b* is applied to the central conductors **108** of the connectors **100***a* and **100***b* through the receptacles **204***a* and **204***b*. The respective external terminals **110** of the connectors **100***a* and **100***b* are maintained at the ground potential through the circuit boards **202***a* and **202***b*, and the receptacles **204***a* and **204***b*. In this way, the high-frequency signal line **10** connects the circuit boards **202***a* and **202***b* to each other.

In this state, the obverse surface of the dielectric body **12** (specifically, the protective layer **14**) is in contact with the battery **206**, and the dielectric body **12** is fixed to the battery pack **206** by an adhesive. Accordingly, the continuous main ground conductor **22** having no openings is located between the signal line **20** and the battery pack **206**.

With reference to the drawings, a non-limiting example of a method of producing the high-frequency signal line **10** is described below. In the following, a producing method of one high-frequency signal line **10** is described as a non-limiting example. Practically, however, by laminating large-size dielectric sheets and by cutting the laminate, a plurality of high-frequency signal lines **10** are produced at one time.

First, dielectric sheets, each formed of thermoplastic resin and having a copper foil (metal film) entirely on one main surface, are prepared as the dielectric sheets **18***a* through **18***c*. Specifically, copper foils are applied to the respective one main surface of the dielectric sheets **18***a* through **18***c*. The surfaces of the copper foils are, for example, galvanized for corrosion proof and thus are smoothened. The dielectric sheets **18***a* through **18***c* are formed of liquid polymer. The thicknesses of the copper foils are within a range from about 10 μm to about 20 μm, for example.

Next, the external terminals **16***a* and **16***b*, and the main ground conductor **22** as illustrated in FIG. **2** are formed on the upper surface of the dielectric sheet **18***a* by patterning the copper foil formed on the upper surface of the dielectric sheet **18***a*. Specifically, resists having identical shapes to the external terminals **16***a* and **16***b*, and the main ground conductor **22** are printed on the copper foil on the upper surface of the dielectric sheet **18***a*. Then, the copper foil is etched, so that the portions of the copper foil not covered by the resists are removed. Thereafter, the resists are removed. In this way, the external terminals **16***a* and **16***b*, and the main ground conductor **22** as illustrated in FIG. **2** are formed on the upper surface of the dielectric sheet **18***a* by photolithography.

Next, the signal line **20** as illustrated in FIG. **2** is formed on the lower surface of the dielectric sheet **18***b*. Further, the auxiliary ground conductor **24** as illustrated in FIG. **2** is formed on the lower surface of the dielectric sheet **18***c*. The process for forming the signal line **20** and the process for forming the auxiliary ground conductor **24** are the same as the process for forming the external terminals **16***a* and **16***b*, and the main ground conductor **22**, and descriptions of the processes are omitted here.

Next, the dielectric sheets **18***a* through **18***c* are exposed to laser beams such that through holes are made in the dielectric sheets **18***a* through **18***c* at the positions of the via-hole conductors b**1** through b**4** and B**1** through B**6**. Thereafter, conductive paste is filled in the through holes, and thus, the via-hole conductors b**1**, b**2** and B**1** through B**4** are formed.

Next, the dielectric sheets **18***a* through **18***c* are laminated in this order from the positive side to the negative side in the z-direction, and heat and pressure are applied to the laminated dielectric sheets **18***a* through **18***c* from the positive and negative sides in the z-direction. By the heat and pressure treatment, the dielectric sheets **18***a* through **18***c* are softened, and the conductive paste filled in the through holes is solidified. Thus, the dielectric sheets **18***a* through **18***c* are joined together, and the via-hole conductors b**1** through b**4** and B**1** through B**6** are formed.

Next, resin (resist) paste is applied to the upper surface of the dielectric sheet **18***a* by screen printing as illustrated in FIG. **2**, and thus, the protective layer **14** covering the main ground conductor **22** is formed.

Next, resin (resist) paste is applied to the lower surface of the dielectric sheet **18***c* by screen printing as illustrated in FIG. **2**, and thus, the protective layer **15** covering the auxiliary ground conductor **24** is formed.

Next, the connector **100***a* is mounted on the connecting portion **12***b* and soldered to the external terminal **16***a* and the terminal conductor **22***b*, and the connector **100***b* is mounted on the connecting portion **12***c* and soldered to the external terminal **16***b* and the terminal conductor **22***c*.

Next, the line portion **12***a* is pinched between pressing tools T**1** and T**2** from the both sides in the z-direction such that the line portion **12***a* is mountain-folded and valley-folded in the portions near the both ends in the x-direction. Specifically, the pressing tool T**1** is a tool configured to come into contact with the reverse surface of the line portion **12***a* and includes stair-step surfaces for the mountain-fold and valley-fold of the line portion **12***a*. In the following, the corner at the bottom of the valley of the pressing tool T**1** is referred to as a corner C**1**, and the corner at the top of the mountain of the pressing tool T**1** is referred to as a corner C**2**. The corners C**1** and C**2** are chamfered. The radius of curvature of the corner C**1** is r1, and the radius of curvature of the corner C**2** is r2.

The pressing tool T**2** is a tool configured to come into contact with the obverse surface of the line portion **12***a* and includes stair-step surfaces for the mountain-fold and valley-fold of the line portion **12***a*. In the following, the corner at the top of the mountain of the pressing tool T**2** is referred to as a corner C**3**, and the corner at the bottom of the valley of the pressing tool T**2** is referred to as a corner C**4**. The corners C**3** and C**4** are chamfered. The radius of curvature of the corner C**3** is r3, and the radius of curvature r3 is greater than the average radius of curvature r2. The radius of curvature of the corner C**4** is r4, and the radius of curvature r1 is greater than the average radius of curvature r4.

The pressing tools T**1** and T**2** are placed such that the corners C**1** and C**3** substantially engage with each other and such that the corners C**2** and C**4** substantially engage with each other. Then, the line portion **12***a* is pinched between the pressing tools T**1** and T**2** from the both sides in the z-direction. It is preferred that heaters are embedded in the respective pressing tools T**1** and T**2** so as to heat the line portion **12***a*. By these tools T**1** and T**2**, the line portion **12***a* is mountain-folded and valley-folded. Consequently, the radius of curvature R1 in the areas A11 where the dielectric body **12** is mountain-folded becomes larger than the radius of curvature R2 in the area A12 where the dielectric body **12** is valley-folded. The high-frequency signal line **10** after undergoing the mountain-fold and valley-fold process is connected to the receptacles **204***a* and **204***b*.

In the high-frequency signal line **10** having the structure above, breakage of the signal line **20** is reliably prevented. Specifically, in the high-frequency signal line disclosed by WO 2012/073591, the signal line provided in the dielectric body is located closer to a first main surface of the dielectric body than to a second main surface. Therefore, when the high-frequency signal line is mountain-folded such that the first main surface comes outside, the signal line **20** is stretched. When the high-frequency signal line is valley-folded such that the first main surface comes inside, the signal line is compressed. In this regard, breakage of the signal line is more likely to occur when the signal line is stretched than when the signal line is compressed.

In the light of this fact, in the high-frequency signal line **10**, as illustrated in FIG. **9**, the radius of curvature R1 in the areas A11 where the dielectric body **12** is mountain-folded is greater than the radius of curvature R2 in the areas A12 where the dielectric body **12** is valley-folded. With this arrangement, in the areas A11, the stretch of the signal line **20** is kept at a small extent. Consequently, in the high-frequency signal line **10**, breakage of the signal line **20** is reliably prevented.

Further, it is possible to make the high-frequency signal line **10** thinner. Specifically, in the high-frequency signal line **10**, in the areas A1, the signal line **20** is not overlapped with the auxiliary ground conductor **24**. Accordingly, in the areas A1, little capacitance is created between the signal line **20** and the auxiliary ground conductor **24**. Therefore, even a reduction in the distance between the signal line **20** and the auxiliary ground conductor **24** will not cause a significant increase in the capacitance between the signal line **20** and the auxiliary ground conductor **24** and will not result in a significant shift of the characteristic impedance of the signal line **20** from a designed value (for example, about 50Ω). Thus, it is possible to make the high-frequency signal line **10** thinner while maintaining the characteristic impedance of the signal line **20** at a designed value.

Even when the high-frequency signal line **10** is fixed to a metal object such as the battery pack **206**, a change in the characteristic impedance is inhibited. More specifically, the high-frequency signal line **10** is fixed to the battery pack **206** such that the continuous main ground conductor **22** is located between the signal line **20** and the battery pack **206**. Therefore, there is no risk that the signal line **20** and the battery pack **206** face each other via openings, and capacitance is prevented from being generated between the signal line **20** and the battery pack **206**. Accordingly, the characteristic impedance of the signal line **20** is prevented from being reduced due to the fixation of the high-frequency signal line **10** to the battery pack **206**.

OTHER PREFERRED EMBODIMENTS

Flexible boards and electronic devices according to the present invention are not limited to the high-frequency signal line **10** and the electronic device **200** described above, and various changes are possible within the scope of the present invention.

In the preferred embodiments described above, the protective layer **14** and **15** are formed preferably by screen printing, for example. However, the protective layers **14** and **15** may be formed by photolithography.

The connectors **100***a* and **100***b* are not indispensable for the high-frequency signal line **10**. In a case where the connectors **100***a* and **100***b* are not provided, both ends of the high-frequency signal line **10** are connected to circuit boards by solder or the like. It is also possible that only the connector **100***a* or **100***b* is provided at only one end of the high-frequency signal line **10**.

In the preferred embodiments described above, the connectors **100***a* and **100***b* are preferably provided on the obverse surface of the high-frequency signal line **10**. However, the connectors **100***a* and **100***b* may be provided on the reverse surface of the high-frequency signal line **10**. Alternatively, the connectors **100***a* and **100***b* may be provided on the obverse surface and the reverse surface, respectively, of the high-frequency signal line **10**.

The main ground conductor **22** and the auxiliary ground conductor **24** are not indispensable for the high-frequency signal line **10**. Neither the ground conductor **22** nor the auxiliary ground conductor **24** may be provided, or alternatively, only one of the ground conductors **22** and **24** may be provided.

The main ground conductor **22** may be provided on the upper surface of the dielectric sheet **18***b*.

The high-frequency signal line **10** may be used as a high-frequency signal line in an RF circuit board such as an antenna front-end module.

The signal line **20** is not necessarily to be used as a signal line to transmit a high-frequency signal. The signal line **20** may be used, for example, as a power-supply line, a ground line to be maintained at the ground potential, or the like.

As thus far described, various preferred embodiments of the present invention are useful in a flexible board and an electronic device, and provide the advantage of inhibiting breakage of a signal line.

While preferred embodiments of the present invention have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing from the scope and spirit of the present invention. The scope of the present invention, therefore, is to be determined solely by the following claims.

What is claimed is:

1. A flexible board comprising:

a flexible body including a first main surface and a second main surface; and

a linear conductor provided at the flexible body so as to be located closer to the first main surface than to the second main surface; wherein

the flexible body is valley-folded along a line crossing the linear conductor such that the first main surface is located inside of the fold, and is mountain-folded along a line crossing the linear conductor such that the first main surface comes is located outside of the fold; and

an average radius of curvature in an area where the flexible body is mountain-folded is greater than an average radius of curvature in an area where the flexible body is valley-folded.

2. The flexible board according to claim **1**, further comprising:

a first ground conductor provided between the linear conductor and the first main surface; and

a second ground conductor provided between the linear conductor and the second main surface; wherein

a distance between the first ground conductor and the linear conductor is smaller than a distance between the second ground conductor and the linear conductor.

3. The flexible board according to claim **2**, wherein an area where the first ground conductor and the linear conductor face each other is smaller than an area where the second ground conductor and the linear conductor face each other.

4. The flexible board according to claim **2**, wherein the first ground conductor contains no openings and the second ground conductor includes openings.

5. The flexible board according to claim **2**, wherein the linear conductor, the first ground conductor and the second ground conductor define a triplate structure.

6. The flexible board according to claim **1**, wherein the flexible body is made of thermoplastic resin.

7. The flexible board according to claim **1**, wherein the flexible body includes a first protective layer, a plurality of dielectric sheets, and a second protective layer laminated on each other.

8. The flexible board according to claim **1**, wherein the linear conductor is a signal line.

9. The flexible board according to claim **1**, further comprising a plurality of via-hole conductors included in the flexible body and linear conductor.

10. The flexible board according to claim **1**, further comprising first and second connectors provided at first and second ends of the flexible body, respectively.

11. An electronic device comprising:

a first high-frequency circuit;

a second high-frequency circuit; and

the flexible board according to claim **1** arranged to connected the first and second high-frequency circuits.

12. The electronic device according to claim **11**, wherein the electronic device is a cell phone.

13. An electronic device comprising:

a case; and

a flexible board housed in the case; wherein

the flexible board includes:

a flexible body including a first main surface and a second main surface; and

a linear conductor provided at the flexible body so as to be located closer to the first main surface than to the second main surface; wherein:

the flexible body is valley-folded along a line crossing the linear conductor such that the first main surface is located inside of the fold, and is mountain-folded along a line crossing the linear conductor such that the first main surface is located outside of the fold; and an average radius of curvature in an area where the flexible body is mountain-folded is greater than an average radius of curvature in an area where the flexible body is valley-folded.

14. The electronic device according to claim **13**, further comprising:

a first ground conductor provided between the linear conductor and the first main surface; and

a second ground conductor provided between the linear conductor and the second main surface; wherein

a distance between the first ground conductor and the linear conductor is smaller than a distance between the second ground conductor and the linear conductor.

15. The electronic device according to claim **14**, wherein an area where the first ground conductor and the linear conductor face each other is smaller than an area where the second ground conductor and the linear conductor face each other.

16. The electronic device according to claim **14**, wherein the first ground conductor contains no openings and the second ground conductor includes openings.

17. The electronic device according to claim **2**, wherein the linear conductor, the first ground conductor and the second ground conductor define a triplate structure.

18. The electronic device according to claim **13**, wherein the flexible body is made of thermoplastic resin.

19. The electronic device according to claim **13**, wherein the flexible body includes a first protective layer, a plurality of dielectric sheets, and a second protective layer laminated on each other.

20. The electronic device according to claim **13**, wherein the linear conductor is a signal line.

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